

What is claimed is:

1. In combination:

a roll-bowl type mill for pulverizing solid fuels for use in firing a steam generator, said pulverizing mill comprising:

a) a bowl having a predetermined diameter;

b) one or more rollers each connected to an assembly through an associated roller bearing, said assembly for holding each of said one or more rollers and for applying a preload on each of said one or more rollers, each of said one or more rollers located a predetermined distance above said bowl; and

c) one or more linear transducers mounted on said assembly to measure the displacement of the movement of said assembly when said mill is operating;

a data acquisition system having as an input said assembly movement displacement measured by said one or more linear transducers comprising:

a computing device for data collection and frequency power spectrum analysis of said assembly shaft displacement to determine:

a) the diameter, D , of each of said one or more rollers by using the formula:

$$D = \frac{F_b}{F_r} D_b$$

b) where, F_b is the bowl frequency and F_r is the roller frequency determined by power spectrum analysis respectively, and D_b is said bowl predetermined diameter.

2. The combination of claim 1 wherein said computing device further determines the reduction and/or depth of wear cup, H , of each of said one or more rollers by using the formula:

$$D_1 = 2R_1 = \frac{F_b}{F_{r1}} D_b$$

$$D_2 = 2R_2 = \frac{F_b}{F_{r2}} D_b$$

$$H = R_1 - R_2 = \frac{|F_{r2} - F_{r1}| F_b D_b}{2F_{r1} F_{r2}}$$

where, F_{r1} is the dominant roller frequency peak from power spectrum analysis F_{r2} is the secondary roller frequency peak from power spectrum analysis.

3. The combination of claim 2 wherein said computing device further determines the relative thickness if said solid fuel in said mill by using the formula:

$$L_1 = \beta \frac{|L| - |L_0|}{|L_0|},$$

where L is the value of the displacement of said journal spring shaft measured by said one or more linear transducers, L_0 is the calibrated value from said one or more transducers, and β is a coefficient.

4. The combination of claim 1 wherein said mill further comprises a wall and a means having one or more vibration sensors mounted thereon for connecting said assembly onto said mill wall and said computing device determines wear of each of said one or more roller bearings by analyzing using vibration pattern signature and/or order analysis methods the signal from each of said one or more vibration sensors.

5. The combination of claim 4 wherein said connecting means is a trunion shaft.

6. The combination of claim 4 wherein said connecting means is said assembly.

7. In combination:

a roll-bowl type mill for pulverizing solid fuels for use in firing a steam generator, said pulverizing mill comprising:

- a) a bowl having a predetermined diameter;
- b) one or more rollers each connected to an assembly through an associated roller bearing, said assembly for holding each of said one or more rollers and for applying a preload on each of said one or more rollers, said one or more rollers located a predetermined distance above said bowl; and
- c) one or more linear transducers mounted on said assembly to measure the displacement of the movement of said assembly when said mill is operating;

a data acquisition system having as an input said assembly movement displacement measured by said one or more linear transducers comprising:

a computing device for data collection and frequency power spectrum analysis of said assembly shaft displacement to determine the reduction and/or depth of wear cup, H , of each of said one or more rollers by using the formula:

$$D_1 = 2R_1 = \frac{F_b}{F_{r1}} D_b$$

$$D_2 = 2R_2 = \frac{F_b}{F_{r2}} D_b$$

$$H = R_1 - R_2 = \frac{|F_{r2} - F_{r1}| F_b D_b}{2F_{r1} F_{r2}}$$

where, F_{r1} is the dominant roller frequency peak from power spectrum analysis F_{r2} is the secondary roller frequency peak from power spectrum analysis.

8. In combination:

a roll-bowl type mill for pulverizing solid fuels for use in firing a steam generator, said pulverizing mill comprising:

- a) a bowl having a predetermined diameter;
- b) one or more rollers each connected to an assembly through an associated roller bearing, said assembly for holding each of said one or more rollers and for applying a preload on each of said one or more

rollers, said one or more rollers located a predetermined distance above said bowl; and

c) one or more linear transducers mounted on said assembly to measure the displacement of the movement of said assembly when said mill is operating;

a data acquisition system having as an input said assembly movement displacement measured by said one or more linear transducers comprising:

a computing device for data collection and frequency power spectrum analysis of said assembly shaft displacement to determine the relative thickness of said solid fuel in said mill by using the formula:

$$L_1 = \beta \frac{|L| - |L_0|}{|L_0|},$$

where L is the value of the displacement of said journal spring shaft measured by said one or more linear transducers, L_0 is the calibrated value from said one or more transducers, and β is a coefficient.

9. A system comprising:

a mill for pulverizing solid fuels for use in firing a steam generator, said mill comprising a predetermined number of components used in pulverizing said solid fuel; and

a processing device for determining an indicator P , where $0 \leq P \leq 1$, for presenting the availability of said mill to perform said solid fuel pulverizing by using the formula:

$$P = \sum_i^n w_i p_i$$

where w_i is the weight factor, $\sum w_i = 1$; and c) is the availability of each individual component of said predetermined number of components and $0 \leq p_i \leq 1$.

10. An apparatus for use with a mill for pulverizing solid fuels for use in firing a steam generator, said mill comprising a predetermined number of

components used in pulverizing said solid fuel, said apparatus comprising:

a computing device for determining an indicator P , where $0 \leq P \leq 1$, for presenting the availability of said mill to perform said solid fuel pulverizing by using the formula:

$$P = \sum_1^n w_i p_i$$

where w_i is the weight factor, $\sum w_i = 1$; and p_i is the availability of each individual component of predetermined number of components and $0 \leq p_i \leq 1$.

11. A computer readable medium having instructions for causing a computer to execute a method comprising:

determining an indicator P , where $0 \leq P \leq 1$, for presenting the availability of a mill for pulverizing solid fuels for use in firing a steam generator, said mill comprising a predetermined number of components used in pulverizing said solid fuel, to perform said solid fuel pulverizing by using the formula:

$$P = \sum_1^n w_i p_i$$

where w_i is the weight factor, $\sum w_i = 1$; and p_i is the availability of each individual component of predetermined number of components and $0 \leq p_i \leq 1$.

12. A method for determining the availability of a mill for pulverizing solid fuels for use in a firing a steam generator, said mill having a predetermined number of components used in pulverizing said solid fuel comprising:

calculating a mill availability indicator, P , where $0 \leq P \leq 1$, in accordance with the following equation:

$$P = \sum_1^n w_i p_i$$

where w_i is the weight factor, $\sum w_i = 1$; and

p_i is the availability of each individual component of said mill and $0 \leq p_i \leq 1$.

13. The method of claim 12 wherein one of said predetermined number of components in said mill pulverizer is an assembly for holding one or more roller bearings and applying a preload on each of said one or more roller bearings and an assembly availability indicator, which is indicative of the thickness of said solid fuel in said mill pulverizer, is determined from:

$$P_i = 1 - \alpha_1 \frac{|L| - |L_0|}{|L_0|}$$

where L is the value of the displacement of said assembly measured by a sensor attached to said assembly, L_0 is the nominal value from said sensor, α_1 is a predetermined coefficient and said weight factor is 0.1.

14. In combination:

a roll-bowl type mill for pulverizing solid fuels for use in firing a steam generator, said pulverizing mill comprising:

- a) a bowl having a predetermined diameter;
- b) a journal assembly;
- c) one or more rollers each connected to said journal assembly through an associated roller bearing, each of said one or more rollers located a predetermined distance above said bowl;
- d) a journal spring shaft accessible from outside of said mill and connected onto said journal assembly, the movement of said journal assembly measurable through said journal spring shaft;
- e) a wall; and
- f) a trunion shaft, one or more vibration sensors mounted on the end of said trunion shaft to measure the vibration of said trunion shaft when said mill is operating, said trunion shaft connecting said journal assembly onto said mill wall; and

a data acquisition system having as an input said trunion shaft vibration measured by said one or more vibration sensors, said having comprising:

a computing device for predicting failure of each of said one or more said roller bearing from said trunion shaft vibration measured by said one or more vibration sensors by first transferring said measured shaft vibration to said location of each of said one or more roller bearings by a predetermined transfer function and then determining wear for each of said one or more roller bearings by analyzing using vibration pattern signature and/or order analysis methods the transferred signal from each of said one or more vibration sensors.